

Designed \_\_\_\_\_

AL-ENG-45a May 1997

**Debris Removal**

Before sealing begins, pumping equipment and any obstacles or debris shall be removed from the well. Dug wells shall be cleaned of debris and refuse using mechanical equipment from the ground surface. Casing that is not sealed should be removed, if possible. Driven and drilled wells should be flushed with water or compressed air if needed to remove materials which would hinder sealing operation.

Proper disposal of displaced fluids and other materials (such as pulled or drilled out casing and cement seals) should be considered. Some of these materials may be classified as hazardous waste under federal, state, or local regulations.

**Measurement of Well Depth and Water Depth**

The depth of the well and the depth of the water shall be measured after debris removal and before well sealing begins.

**Safety Consideration**

When sealing operations are temporarily suspended, such as overnight shut down or awaiting materials, the well or hole shall be covered. The cover shall be anchored to prevent easy or unintentional entry and sealed to prevent the seepage of surface water and foreign material into the well or hole. If a well pit must be entered, workers shall comply with all OSHA safety regulations. Hard hats should be worn around heavy equipment.

**Chlorination**

The water in the well shall be brought to a 100 ppm chlorine concentration before sealing.

A 100 ppm chlorine solution will require:

1 gal. 5% chlorine bleach per 500 gal. of water

1 pt. 5% chlorine bleach per 62 gal. of water

1.3 lbs. high-test calcium hypochlorite tablets per 1,000 gal.

To determine the volume of water in the well, use the chart shown in the Materials section.

**Materials**

An estimate of the amount of materials needed to seal the well should be calculated prior to construction.

An estimate of the borehole volume can be calculated as follows:

$$V = 3.1416 \cdot D^2 \cdot L/4$$

where:

V = volume (cu. ft.)  
D = diameter of hole (ft.)  
L = length of hole to be sealed (ft.)

To determine the volume of water in the well or the volume of materials needed per foot of depth, use the following chart.

Hole diameter (inches)	Volume per foot of depth	
	gal/ft	cu ft/ft
4	0.7	0.1
6	1.5	0.2
8	2.6	0.3
10	4.1	0.5
12	5.9	0.8
14	8.0	1.1
16	10.4	1.4
20	16.3	2.2
24	23.5	3.1
36	52.9	7.1
48	94.0	12.6

Materials used in decommissioning abandoned wells are as follows:

**Bentonite.** Predominantly composed of the clay mineral sodium montmorillonite which swells when wet. Pelletized bentonite consists of granular bentonite which has been compressed into tablets. Pelletized bentonite with a soluble coating is recommended for sealing wells. Chipped bentonite is raw mined in the form of chunks 1/4 to 3/4 inch in size. As bentonite chips are difficult to place, they should be used with caution. Granular and powdered forms of bentonite are not recommended for dry placement in well sealing operations.

**Cement-bentonite slurry.** A mixture of cement, bentonite, and water, consisting of not more than eight (8) percent bentonite by dry weight of the cement and a maximum of ten (10) gallons of water per sack (94 pounds) of cement.

**Cement grout.** Mixture of cement, sand (1:1 patio) and water [not more than 6 gal. of water per sack (94 lbs.) of cement.]

**Grout.** Material consisting of bentonite, cement, or a cement-bentonite mixture.

**High solids clay grout.** Blend of powdered polymer-free bentonite clay mixed with water that forms a creamy slurry with a minimum of 20% solids by weight and a density of 9.4 lb./gal.

**Local Clay Subsoil.** Any clayey material of local origin found below the topsoil. It should have a medium or loamy texture or be classified a silty clay (CL-ML) or lean clay (CL) in the Unified Soil Classification System.

**Neat cement.** Neat cement is a mixture of one bag (94 pounds or 1 cubic foot) of portland cement and 6 gal. of water. It is about the consistency of thick cream and can be pumped with special piston pumps. The mixture of one 94 lb. bag of cement and 6 gal. of water yields a volume of 1.1 cubic foot.

**Sand.** Sand shall be clean sand.

**Sand/gravel mix.** Material shall be clean. Gravel shall have a maximum size of 1/10 of the well diameter. Materials greater than 3 inches should not be used regardless of the well diameter.

The above mixtures may be varied to improve pumping, gravity flow, expansion, etc., as approved by the engineer.

**Handling and Placement of Materials**

**Cement.** If cement is used to seal the well, it shall continue to be placed to within 4 ft. of the ground surface. Cement shall be placed through a pipe from the bottom of the well. The pipe should be raised slowly as the cement is added. Complete this operation in one continuous operation. The cement mix will displace the water if installed with a pipe as specified. When the overflowing cement is similar to that being pumped down the hole, the sealing is considered complete. As a precaution, free-standing water present in the well prior to the placement of cement should be bailed or pumped out, if possible.

Neat cement is generally preferred to grout as it avoids the danger of separation.

**Bentonite.** If bentonite is used, it should be screened through a ¼ in. mesh to remove dust and fine particles which would tend to clog when being added to the well. The bentonite should be added slowly at a rate of about one bag (50 lbs.) per five minutes to prevent bridging unless otherwise recommended. The bentonite should become saturated with water as it is placed in the well. If there isn't sufficient water in the well to saturate the bentonite, water should be added at a rate of 8 gal. per bag.

Use bentonite chips or pellets only where it is practical to place. Bentonite chips and pellets have a tendency to stick to the damp side walls

of the well, causing bridging. Dry bentonite should be tamped in place to ensure bridging does not occur. In deep holes, one of the slurry materials should be used.

Use caution when using bentonite in saline ground water, due to shrinkage that may occur when in contact with high concentrations of salt.

**Local Clay Subsoil.** Compacted local clay subsoil shall be moist so as to obtain good compaction. The clay shall be compacted in 6 in. layers with a 2x4 or 4x4 board, a long pipe with a flat end, or other suitable tamping device.

**Sand/Gravel Mix.** If over 20 ft. of sand/gravel is used in filling the well above the water level seal, an intervening 3 ft. seal of bentonite or cement shall be placed about halfway in the sand column, or at 20 ft. intervals in deep wells.

**Inspection**

NRCS representative should be on-site during field activities to verify that the activities are completed as planned. Written certification of conformance to specifications will be required if physical inspection is not conclusive.

**Sealing Procedure**

The well casing and bore hole shall be completely filled with materials as stated in this specification and shown on the drawing, including the annular space outside of the casing or liner.

**Surface seal.** All wells will have a surface seal as follows:

A 3 ft. plug of cement shall be placed in the well to within 3 ft. of ground level, forming a seal from 6 ft. to 3 ft. below the surface.

A pit shall be excavated around the upper 3 ft. of the well. The pit diameter shall exceed the diameter of the casing by at least 4 ft. The casing, if it has not been pulled, should be cut off at the base of the pit. With dug wells, the upper 3 ft. of the well lining should be removed. The pit shall be backfilled with a 1.5 ft. thick layer of bentonite or cement-bentonite slurry. The 1.5 ft. of bentonite shall be overlain with compacted, low permeability soil, mounded to direct surface water away from the abandoned well location. The mounded soil shall be sodded or seeded with appropriate vegetation and mulched, unless the area is to be utilized for crop production.

**Well Pits.** To properly abandon a well pit, knock in at least one wall, breakup or perforate the floor, and then fill the pit using the procedure for dug wells.